



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Alternative magnesium source for phosphorous recovery – a feasibility and economic analysis

Quist-Jensen, Cejna Anna; Jørgensen, Mads Koustrup; Christensen, Morten Lykkegaard

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Quist-Jensen, C. A., Jørgensen, M. K., & Christensen, M. L. (2016). *Alternative magnesium source for phosphorous recovery – a feasibility and economic analysis*. Poster presented at Nordic Filtration Symposium, Lappeenranta, Finland.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

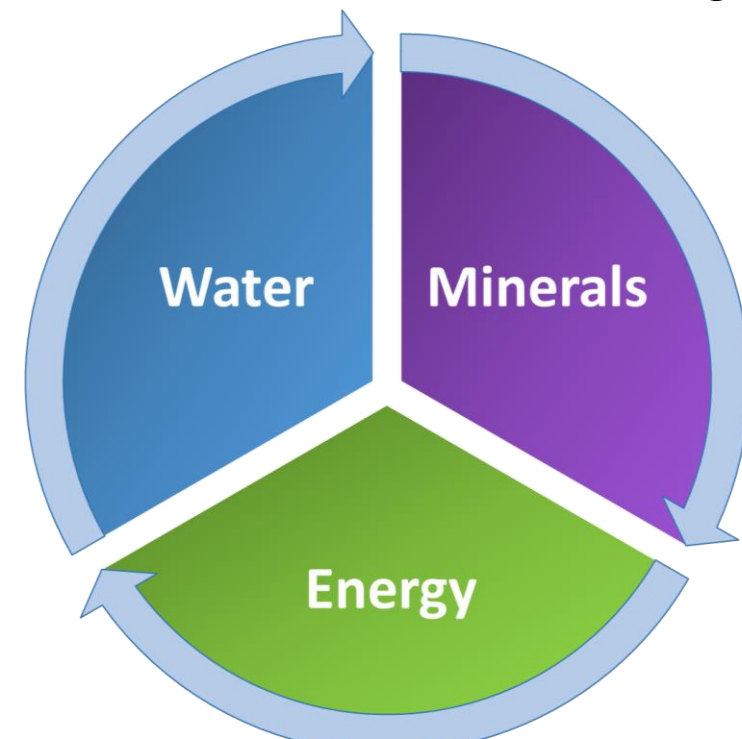
If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Alternative magnesium source for phosphorous recovery – a feasibility and economic analysis

Cejna A. Quist-Jensen^{*1}, Mads K. Jørgensen¹, Morten L. Christensen¹

¹Department of Chemistry and Bioscience, Aalborg University, Fredrik Bajers Vej 7H, 9220 Aalborg East, Denmark
(*cejna@bio.aau.dk)

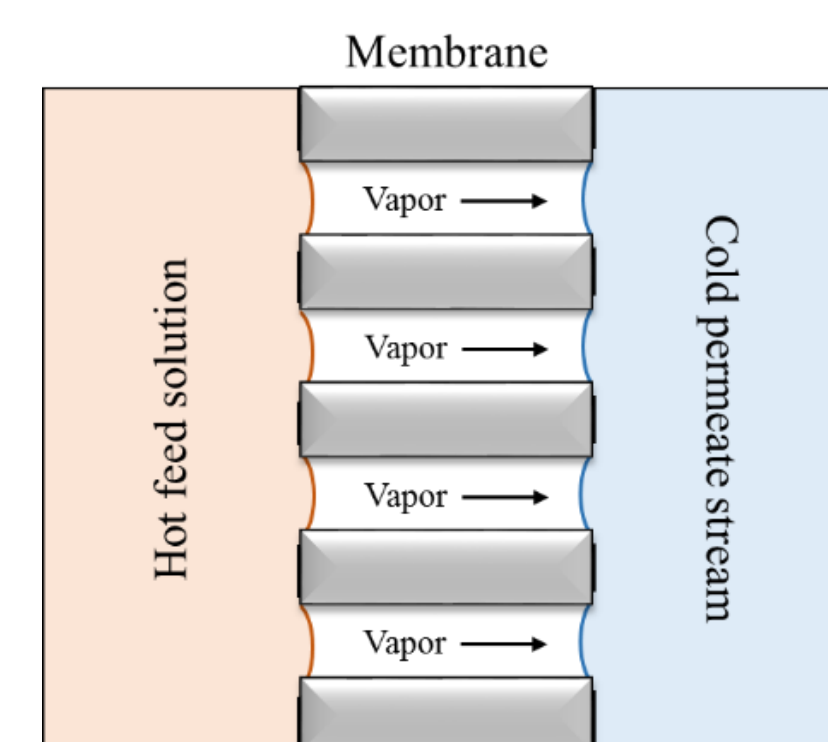
Minerals-water-energy nexus



Sustainability in mineral extraction might be realized by redesigning the conventional mining industry. Minerals can be recovered from waste streams by using membrane crystallization.

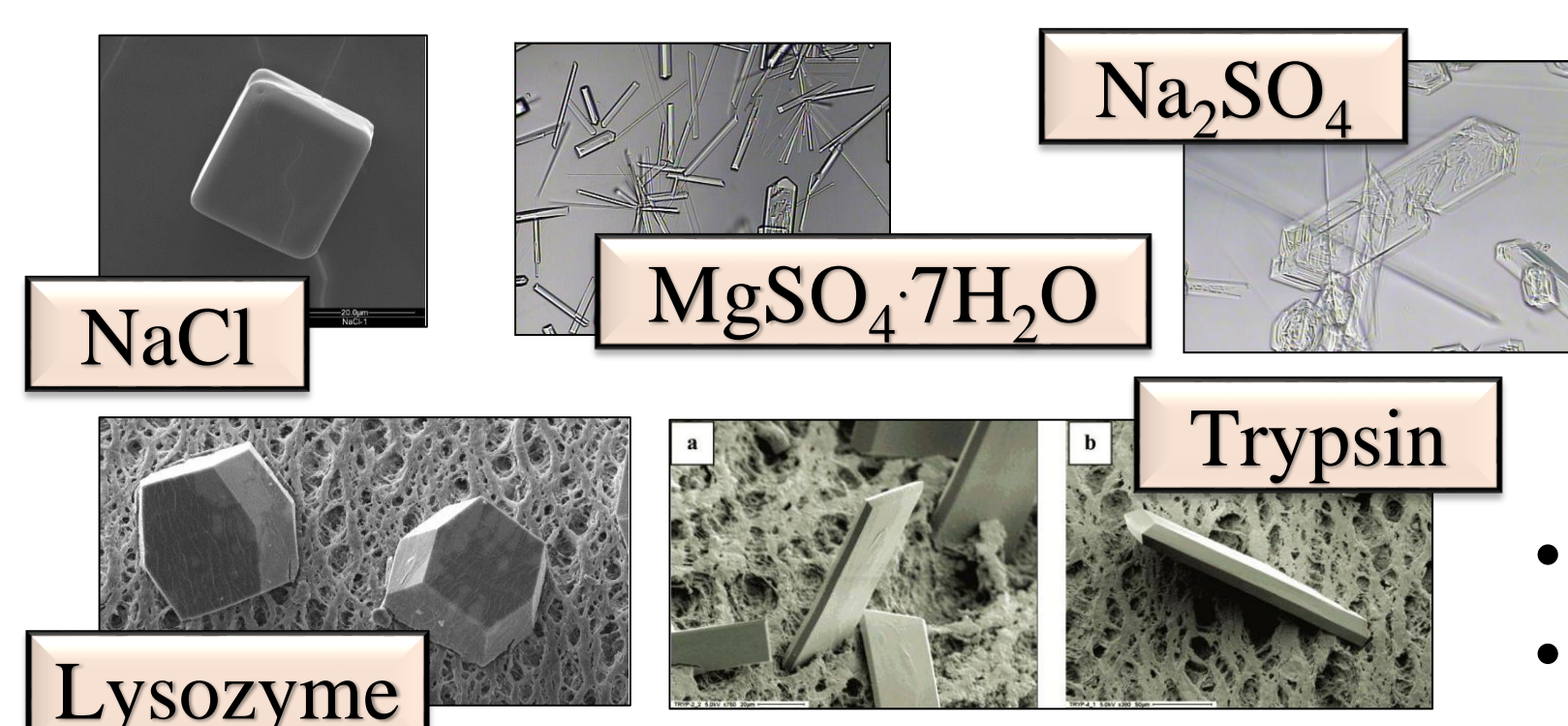
Concept of Membrane Crystallization

- Minor effect of concentration on process performance.
- Potential to use low-grade heat energy.
- High product quality.
 - Theoretical 100 % rejection of non-volatiles.



Membrane Crystallization

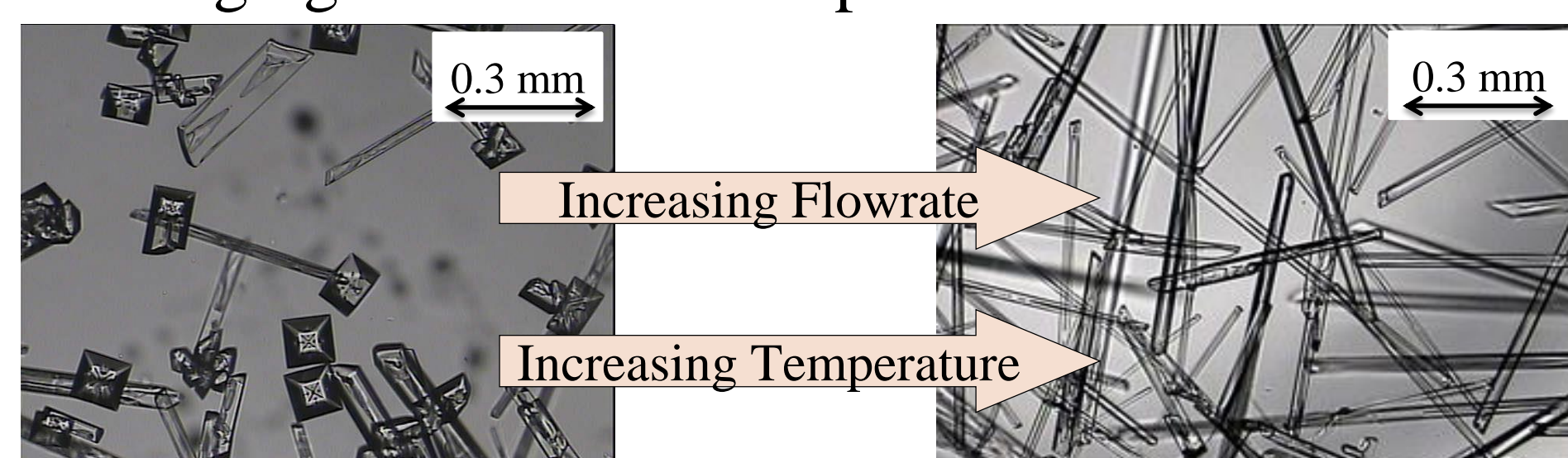
What has been recovered?



- Low CV
- Controlled nucleation and growth
- High purity
- Tunable polymorph

Process control

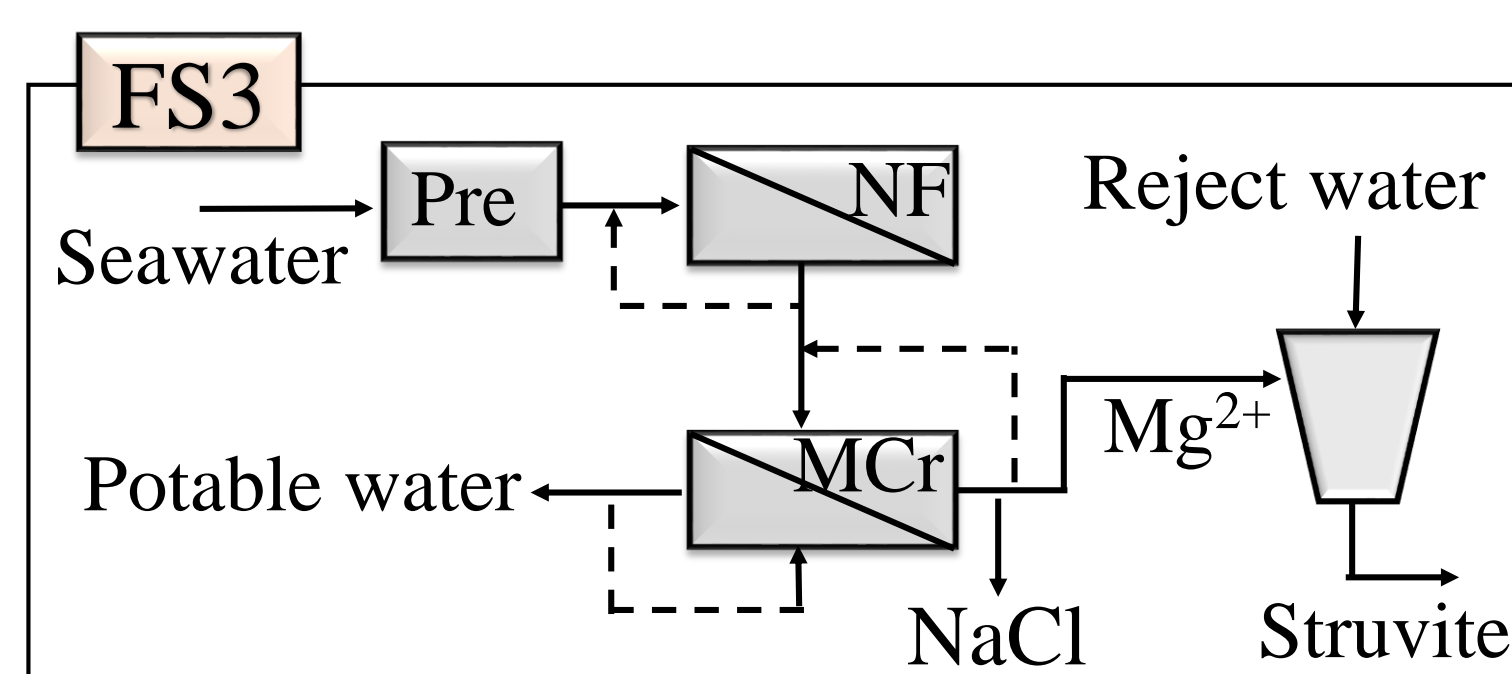
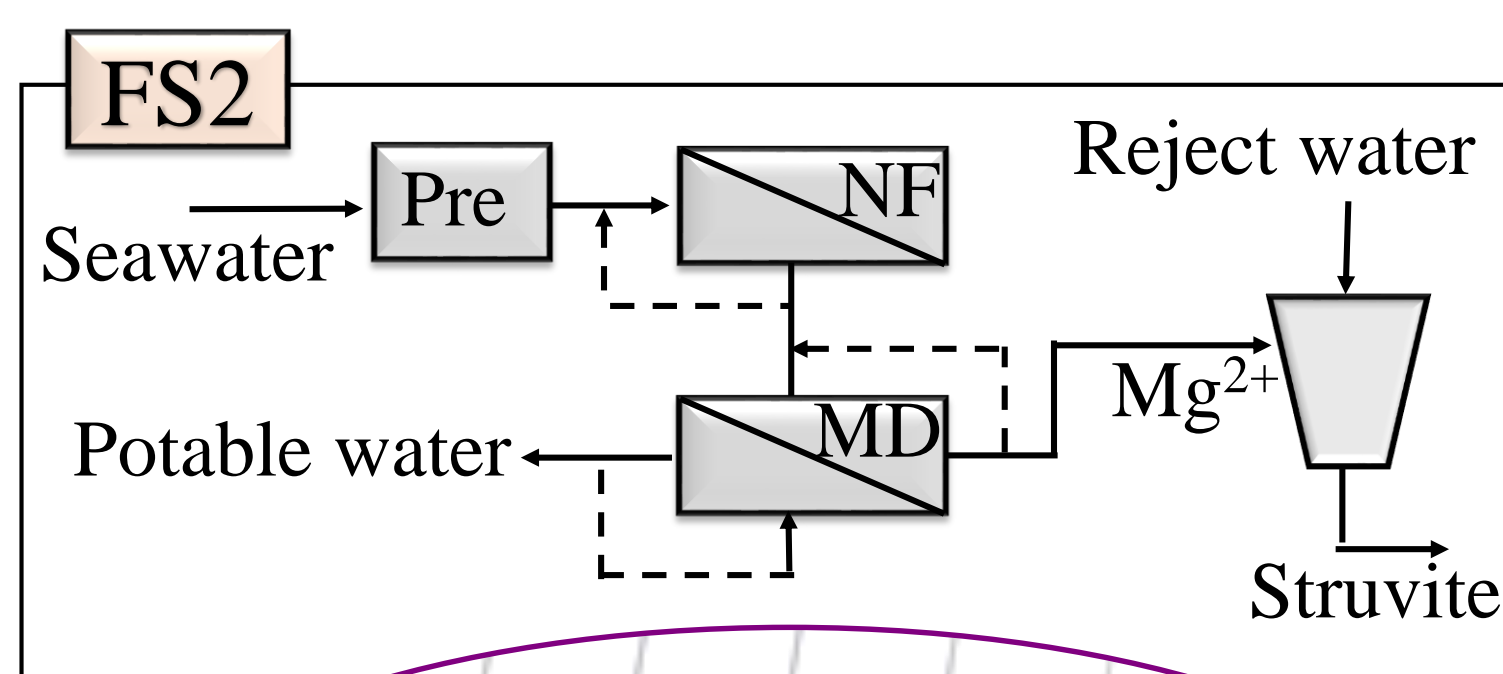
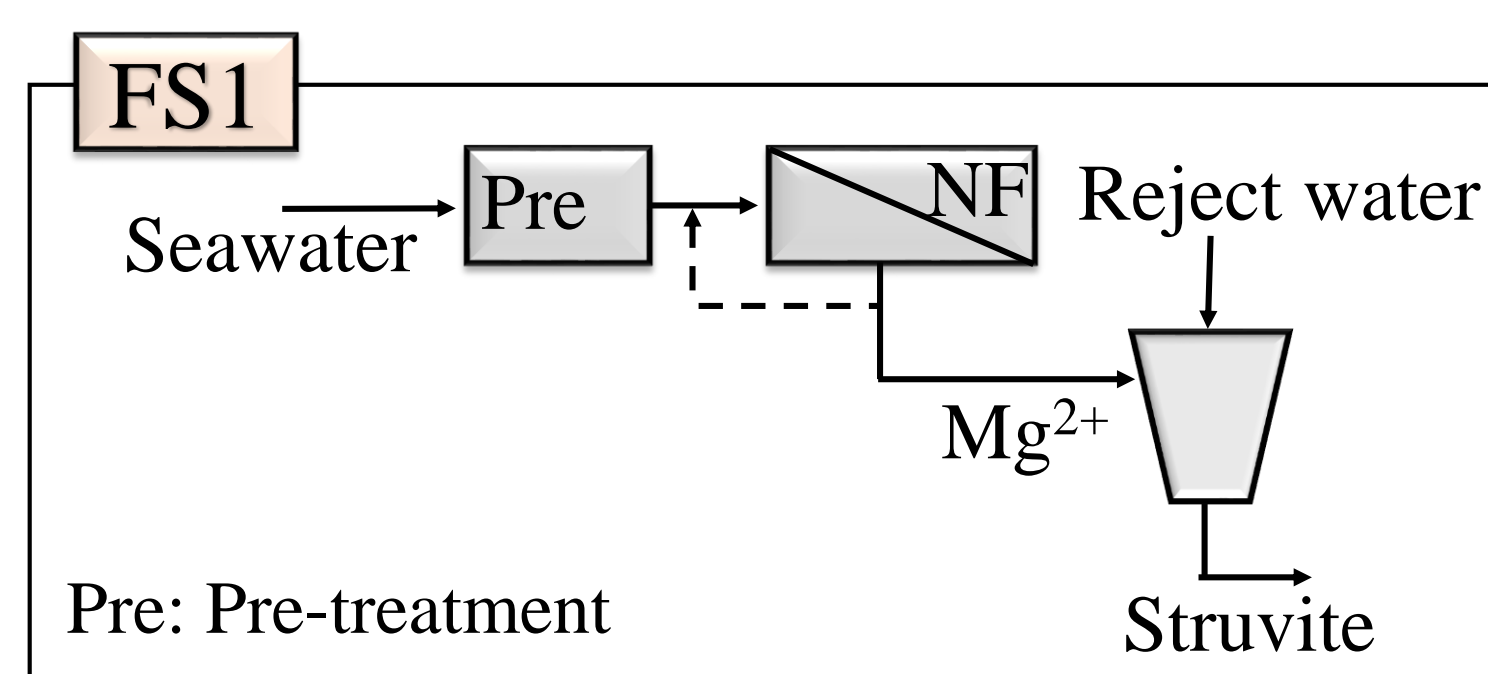
Different polymorphs can be crystallized by changing flowrate and temperature – shown here for LiCl.



Concept of phosphorous recovery

Efficient struvite ($\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) recovery requires pH control and a higher magnesium concentration than the one found in wastewater. Instead, magnesium is often added as $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$. However, this stresses the overall sustainability and economic feasibility. Seawater is a cheap source of magnesium, but chloride ions create problems for the downstream treatment.

Consequently, seawater treatment is required before addition to wastewater.

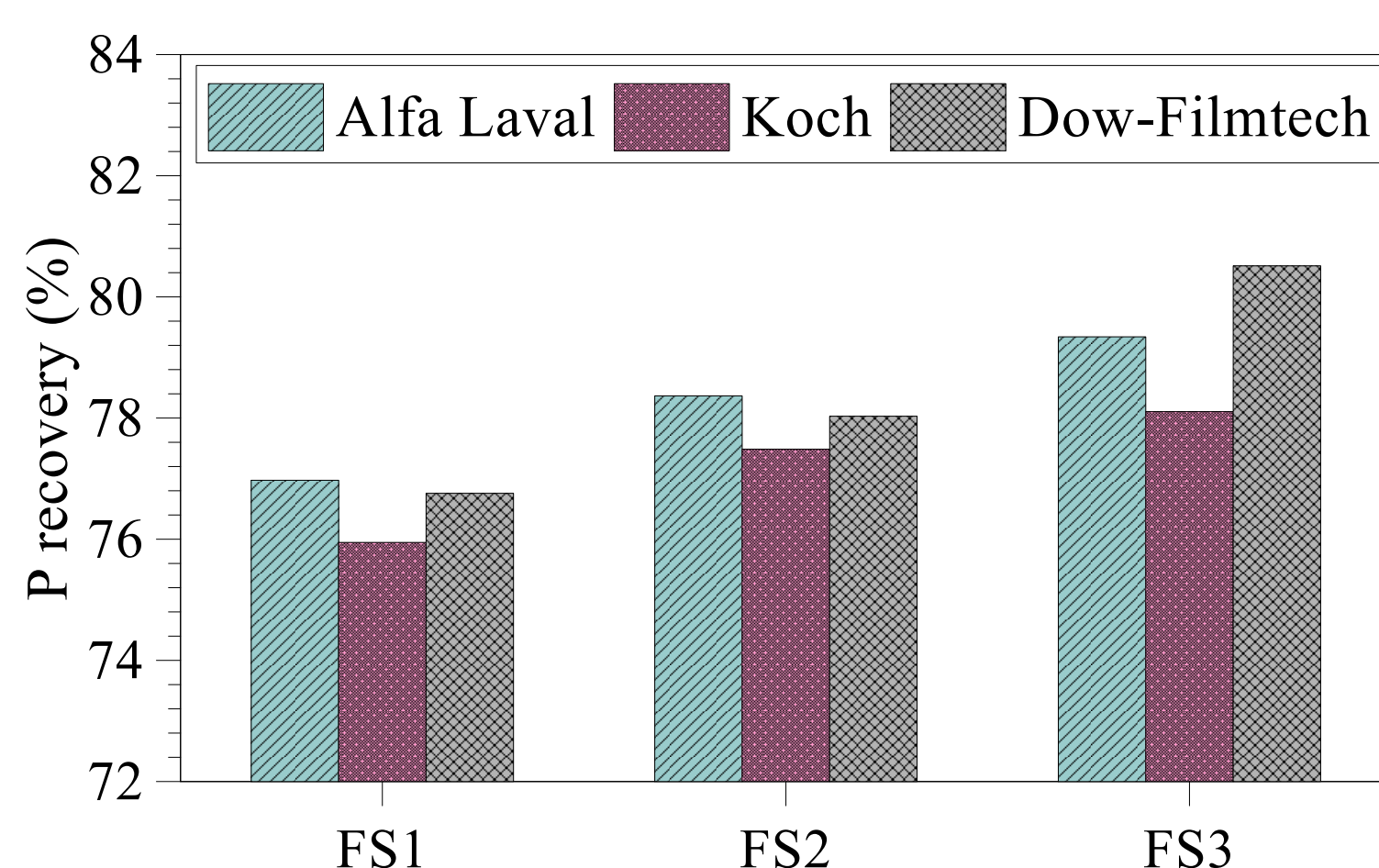


NF: Nanofiltration, MD: Membrane Distillation

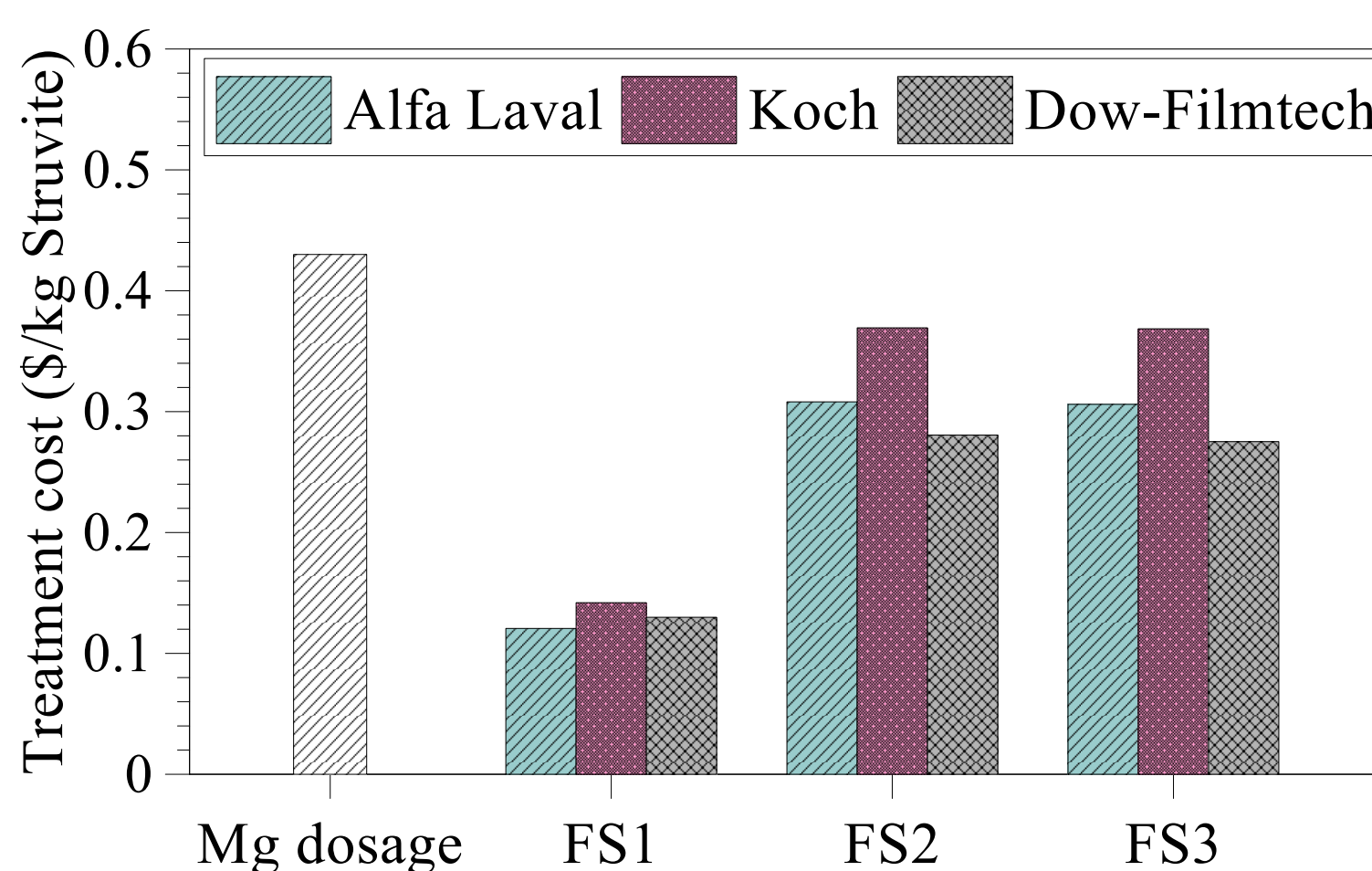
MCr: Membrane Crystallization

Phosphorous Recovery

Economic analysis

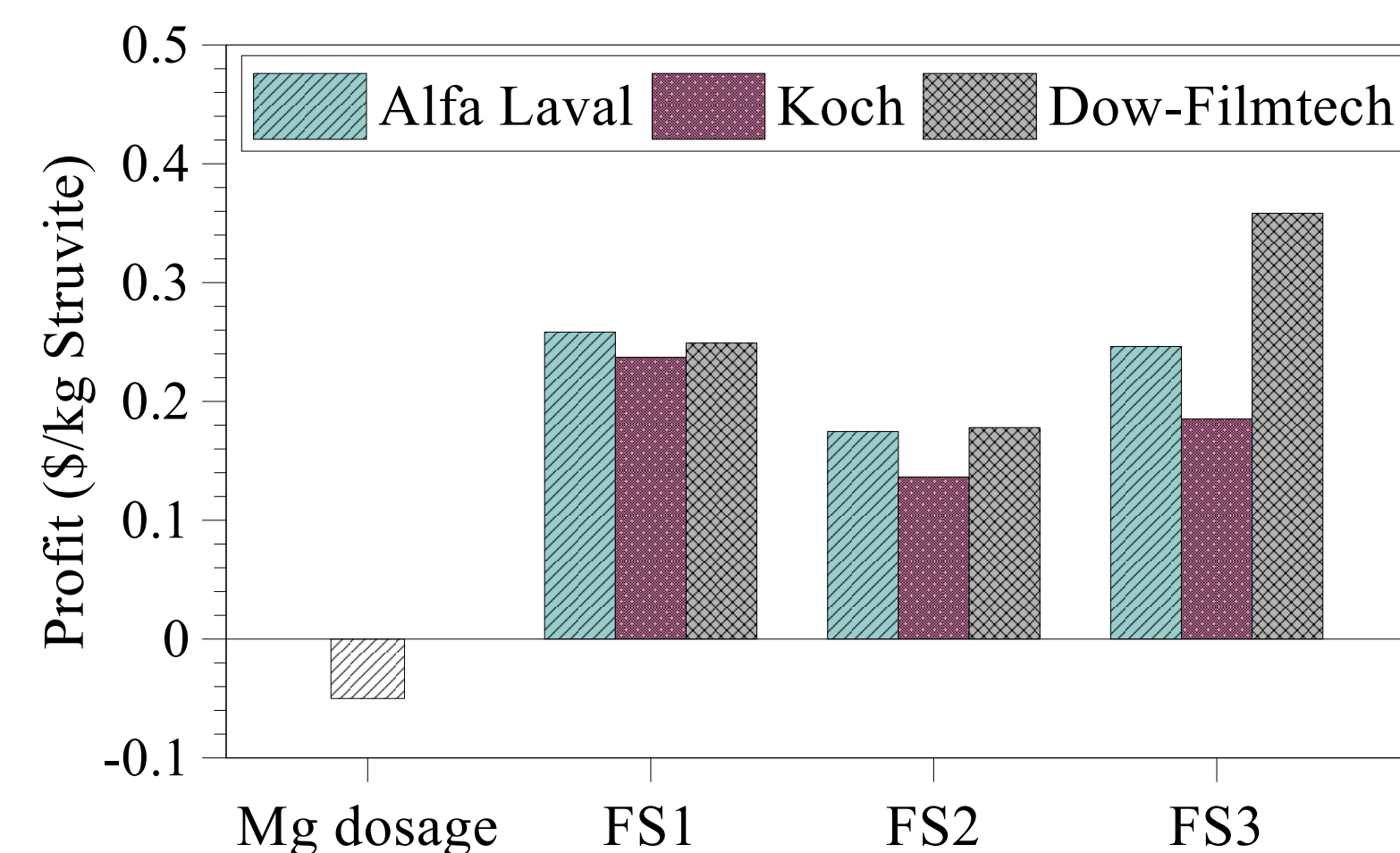


Phosphorous recovery from reject water using treated seawater as magnesium source.



Treatment cost for the different flow sheets and NF membranes.

Different treatment options (shown above) and three NF membranes have been considered.



Profit for the different flow sheets and NF membranes

Conclusion

- All the treatment options are able to recover more than 75 % of phosphorous at pH 7.5 (Theoretical estimations).
- The lowest cost is found to be only NF treatment, whereas MD and MCr require additional cost for the equipment and operation and maintenance costs.
- On the other hand, FS2 produces additional fresh water and FS3 produces fresh water and NaCl.

Acknowledgement

The authors acknowledge the financial support of the Innovation Fund Denmark for the grant to the ReCoverP Project.

References

- Quist-Jensen et al., *Crystals* (6), p. 36, 2016.
 Ali et al., *Membranes*, (5), p. 772–792, 2015.
 Quist-Jensen, et al., *Desalin. Water Treat.* (57), 2015.
 Quist-Jensen et al., *Desalination*, 2016. In press.
- Di Profio et al., *J. Cryst. Growth*, (257), pp. 359–369, 2003.
 Di Profio et al., *Ind. Eng. Chem. Res.* (44), pp. 10005–10012, 2005.
 Quist-Jensen et al. *J. Memb. Sci.* (505,) pp. 167–173, 2016.